The University of Texas Publication

No. 4037 October 1, 1940

ESTABLISHING A CHEESE FACTORY IN TEXAS

FUNDAMENTAL CONSIDERATIONS

By

MONROE W. KRIEGEL, Ph.D.
Research Technologist
Bureau of Industrial Chemistry

BUREAU OF INDUSTRIAL CHEMISTRY
E. P. Schoch, Director

PUBLISHED BY
THE UNIVERSITY OF TEXAS
AUSTIN

Publications of The University of Texas

The University publishes bulletins four times a month, so numbered that the first two digits of the number show the year of issue and the last two the position in the yearly series. (For example, No. 4001 is the first publication of the year 1940.) These bulletins comprise the official publications of the University, publications on humanistic and scientific subjects, and bulletins issued from time to time by various divisions of the University. The following bureaus and divisions distribute publications issued by them; communications concerning publications in these fields should be addressed to The University of Texas, Austin, Texas, care of the bureau or division issuing the publication: Bureau of Business Research, Bureau of Economic Geology, Bureau of Engineering Research, Bureau of Industrial Chemistry, Bureau of Public School Extracurricular Activities, and Division of Extension. Communications concerning all other publications of the University should be addressed to University Publications, The University of Texas.

Additional copies of this publication may be procured from the Bureau of Industrial Chemistry, The University of Texas, Austin, Texas
at
20c per copy

THE UNIVERSITY OF TEXAS PRESS

The University of Texas Publication
No. 4037: October 1, 1940

ESTABLISHING A CHEESE FACTORY IN TEXAS

FUNDAMENTAL CONSIDERATIONS

By

MONROE W. KRIEGEL, Ph.D.
Research Technologist
Bureau of Industrial Chemistry

BUREAU OF INDUSTRIAL CHEMISTRY
E. P. Schoch, Director

PUBLISHED BY THE UNIVERSITY FOUR TIMES A MONTH AND ENTERED AS SECOND CLASS MATTER AT THE POST OFFICE AT AUSTIN, TEXAS, UNDER THE ACT OF AUGUST 24, 1912

The benefits of education and of useful knowledge, generally diffused through a community, are essential to the preservation of a free government.

Sam Houston

Cultivated mind is the guardian genius of Democracy, and while guided and controlled by virtue, the noblest attribute of man. It is the only dictator that freemen acknowledge, and the only security which freemen desire.

Mirabeau B. Lamar

CONTENTS

PREFACE

The great social and economic changes which are taking place in many parts of the world are naturally also affecting Texas, and compelling its citizens to find new means of earning a livelihood. Many citizens and organizations are devoting time, thought, and effort to the solution of the problems involved in these changes—and Governor O'Daniel has centralized these efforts and organized them into an effective State unit under the title: Texas Industrialization Program. This central unit is operated under Governor O'Daniel's personal direction—in his office. He has brought about the organization of two hundred and thirty-five community units called "Governor's Industrialization Committees," and he has secured the coöperation of the Texas agencies which are concerned with problems of public welfare and industry—all with the view of giving Texas citizens the help and direction obtainable from all available agencies.

One of the most frequently mentioned topics in this industrialization program is the establishing of dairy industries—and in this connection it was found that the gathering of the available information still entailed much labor on the part of someone capable of collecting and arranging it. In other words, the information needed is available somewhere, but special time and effort is needed to gather it. This would have to be done by each one of the communities for itself, and hence this work would not only delay—and through this delay possibly discourage—the actual establishing of some of these enterprises, but it would involve a wasteful duplication of effort. Hence the Bureau of Industrial Chemistry of The University of Texas has undertaken the publication of a set of bulletins on the establishing of various industries, which bulletins present information gathered from other agencies rather than that obtained from its own research only, but which is gathered with care, and with the view of making this information more

directly serviceable. "Establishing a Cheese Factory in Texas" is the first of these bulletins.

This preface should not be closed without a word of caution to prevent a possible "kick-back" from this type of publication: no community should rush blindly or precipitously into such a venture, and the total number of such ventures started simultaneously should not exceed the commercial demand.

The first part of this caution can be observed individually—for instance, by making the proper inquiry of the various agencies serving on the Governor's Industrialization Program.

The second part of this caution—namely that the total number of such ventures started simultaneously should not exceed the commercial demand—requires collective action. There should be some central office which the various communities advise of their intention and from which they can learn who else is undertaking such a development. The Industrial Staff in the Governor's Office is equipped to give such information and should be consulted before new enterprises are started. While this is a very delicate matter because investors frequently do not wish to reveal their plans, yet a procedure such as that indicated above may prevent many commercial failures, and in the end will benefit all parties.

E. P. SCHOCH.

ACKNOWLEDGMENT

The author wishes to express his appreciation to the following who contributed to the preparation of this report: Dr. F. A. Buechel, Bureau of Business Research, The University of Texas; Professor C. N. Shepardson, Head of Dairy Husbandry Department, Texas A. & M. College; Mr. A. J. Riddle, Kraft-Phenix Cheese Corporation; Mr. August Kaufman, Armour and Company; Mr. I. A. Mahon, Creamery Package Company; Mr. T. R. Hershfelt, Meyer Blanke Equipment Company; Mr. V. M. Ehlers, State Health Department; Mr. M. E. McMurray, Texas Dairy Products Association; and various officials with the United States Department of Agriculture and Farm Credit Administration.

MONROE W. KRIEGEL.

ESTABLISHING A CHEESE FACTORY IN TEXAS

FUNDAMENTAL CONSIDERATIONS

Introduction

In connection with the general industrialization idea in Texas groups in many communities have become interested in securing new outlets for their raw materials. As the farm income from cotton continues to decrease, more attention is being given to other sources of revenue. Chief among these new industries is the production of milk and the manufacture of dairy products. In 1929 (1) the revenue from cotton lint and cottonseed comprised 62.12 per cent of the farm income while that from milk and milk products made up only 5.4 per cent. Since then there has been a steady increase in the income derived from milk and milk products. While the demand for fluid milk is comparatively definite and is being filled by nearby dairies, there is a much wider market for products made from milk.

The principal milk products are butter, ice cream, cheese, casein, evaporated milks and powdered milks. The production and economics of each of these necessitates a large amount of study. Many communities have written this Bureau for information of a general nature regarding the factors involved in the establishment of plants for the processing of milk. Because much interest was shown in the cheese industry and in the establishment of cheese plants, it was felt that a general information bulletin concerning this industry might be valuable to the people of this State. The purpose of this work is to point out some of the problems which arise in the location and building of a plant, and to show where definite help can be obtained on these problems. This is not written for the purpose of encouraging the building of new cheese plants over the State. The building of too many plants would result in an economic loss both to the investor and to the farmer marketing his

milk. The development of dairying and the production of large quantities of surplus milk must precede the establishment of new cheese factories. But the farmer wants to be assured of the establishment of a steady market before he undertakes the production of a new raw material. This bulletin shows where definite assistance may be obtained *when a community becomes ready for the building of a cheese plant.*

MANUFACTURING

General Facts Concerning Milk and Cheese

Milk may be technically defined as the normal secretion of the mammary glands of a mammal. Most of the cheese in this country is made from cow's milk; although the milk of the ewe, goat, buffalo, camel, and reindeer are used in other countries. Milk is made up of water, fat, protein (casein and albumin), milk sugar or lactose, and ash; or water, fat, and solids-not-fat. The relative amounts of these vary with the breed, the individual cow, the environment, the food, and many other factors. The variations in composition of milk are shown in Table I.

TABLE I

COMPOSITION OF MILK

	Water Per Cent	Fat Per Cent	Casein Per Cent	Sugar Per Cent	Albumin Per Cent	Ash Per Cent
High	88.90	5.50	3.00	5.00	.72	.73
Low	85.05	3.00	2.10	4.60	.70	.70
Average	87.47	3.80	2.50	4.80	.71	.72

Reference: Thom and Fisk, *The Book of Cheese*, p. 6 (13).

Manufacture of most dairy products, other than ice cream or sweet condensed milk in which materials are added to the milk, is simply a separation of the constituents of milk into two or more products, either or both of which must have more potential value than the milk from which they were separated. This value may be in actual cash or

in ease of marketing. In cheese making the proportions of the milk constituents are changed relative to one another. Table II shows the average compositions of various dairy products. The last column in this table shows how 1,000 pounds of milk may be broken up into 909 pounds of skim milk and 91 pounds of cream (this cream may be made into 44 pounds of butter and 47 pounds of buttermilk), or 899 pounds of whey and 101 pounds of cheese, or 425 pounds of condensed whole milk, etc., depending on which products are desired.

TABLE II

THE WATER, FAT, AND SOLIDS-NOT-FAT CONTENT OF DIFFERENT DAIRY PRODUCTS DERIVED FROM A CERTAIN WHOLE MILK
(In Percentages)

Constituents	Whole Milk	Skim milk	Cream	Butter	Butter-milk	Cheese Cheddar	Whey
Water	87.75	91.08	54.62	16.00	90.83	38.00	93.30
Fat	3.75	.10	40.00	83.00	.40	30.00	.30
Milk solids not fat	8.50	8.82	5.38	1.00	8.77	32.00	6.40
Total solids	12.25	8.92	45.38	84.00	9.17	62.00	6.70
Pounds product per 1,000 lbs. whole milk	1,000	909	91	44	47	101	899

TABLE II—(Continued)

Constituents	Sweet-ened Con-densed Whole Milk	Plain Bulk Con-densed Skim Milk	Plain Bulk Con-densed Whole Milk	Evap-orated Milk	Ice Cream Mix	Whole Milk Pow-der	Skim Milk Pow-der
Water	26.50	74.50	70.00	74.50	66.00	5.00	5.00
	45.50 sugar				13.50 sugar, etc.		
Fat	8.00	.29	8.00	7.80	8.00	29.09	1.07
Milk solids not fat	20.00	25.21	22.00	17.70	12.50	65.91	93.93
Total solids	73.50	25.50	30.00	25.50	34.00	95.00	95.00
Pounds product per 1,000 lbs. whole milk	425	397	386	481	680	129	85

Reference: Mojonnier and Troy, *The Technical Control of Dairy Products*, p. 11 (7).

Unripened cheese is composed primarily of the casein, most of the fat, insoluble salts and colloidal matter, part of the water, and part of the lactose, albumin, and soluble salts originally present in the milk. The coagulation of these solids into curd is accomplished slowly by the action of bacteria, or rapidly by the addition of rennet. Thus cheese making is essentially a separation of the constituents of milk into one material having a low water, high fat, and high casein content and another material having a high water, low fat, and low casein content. This is shown in Figure 1. Both the cheese and the whey have a fairly definite market value, the former for human and the latter for stock consumption. Whey, when used as food for hogs, is worth about one-half as much as skim milk, or 100 pounds is worth one-fourth as much as a bushel of corn (18).

Manufacture

According to Doane (3) there are 287 kinds of cheese produced in the world. He lists briefly the method of manufacture and the analysis of each. According to Rogers (10), cheese may be classified on the basis of method of manufacture into the following types:

- Soft
  - Unripened
    - Cottage
    - Cream
    - Neufchatel
  - Ripened
    - Ripened by molds
      - Camembert
      - Brie
    - Ripened by bacteria
      - Limburger
      - Liederkranz
- Hard
  - Semi-hard
    - Ripened by molds
      - Gorgonzola
      - Roquefort
      - Stilton
    - Ripened by bacteria
      - Brick
      - Münster
  - Very hard
    - Without gas holes
      - Cheddar
      - Edam
      - Gouda
    - With gas holes
      - Emmenthal
      - Swiss
      - Parmesan

The making of American cheese is well described by Sammis (11), Thom and Fisk (13), and Van Slyke and Price (16). One cannot learn how to make cheese by simply reading one of these books, for the art of successful

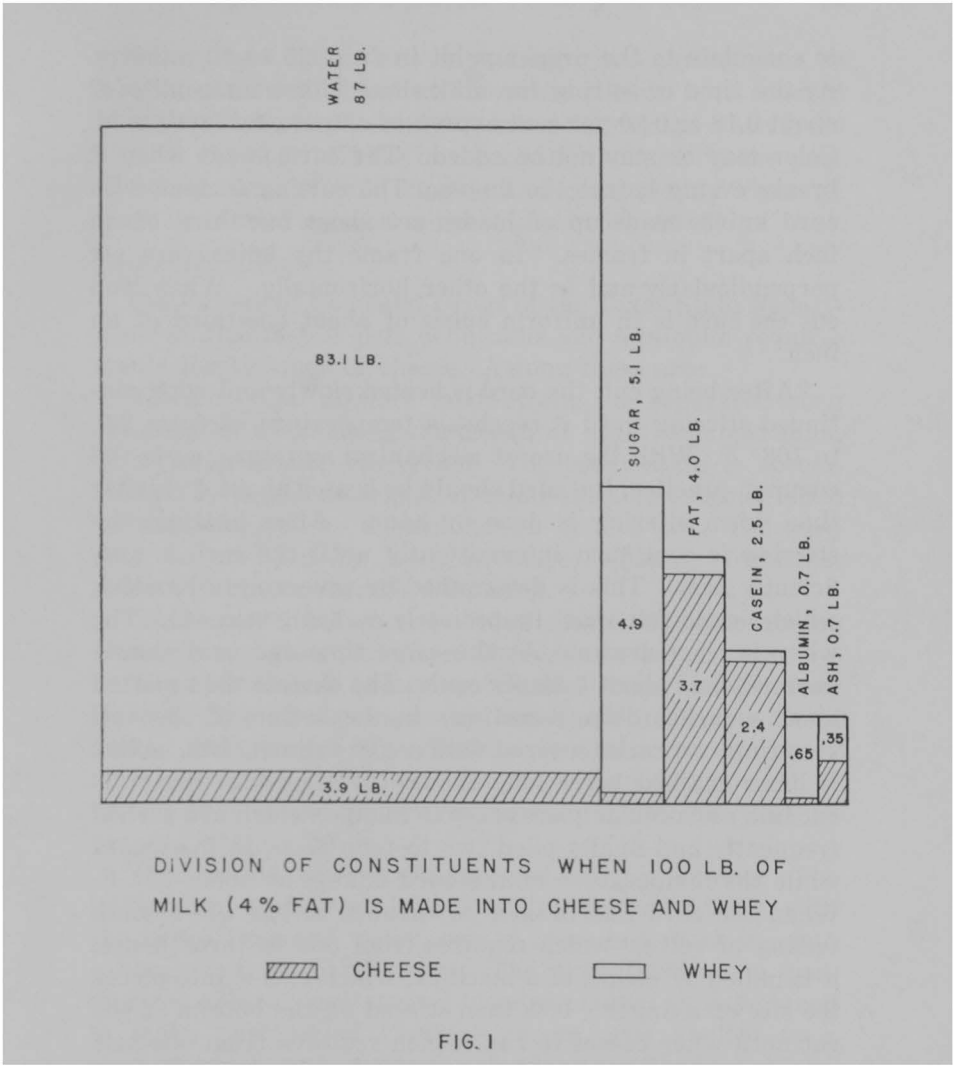

FIG. 1

cheese making is acquired only through experience in actual plant operation. The following brief outline from Doane (3) points out the steps involved and is presented in order to acquaint the layman with the subject:

"The milk, morning's and evening's mixed, is set at 85°F. with sufficient rennet (made from extract of calf stomach)

to coagulate to the proper point in from 25 to 40 minutes. At the time of setting the milk should have an acidity of about 0.18 or 0.20 per cent expressed as per cent lactic acid. Color may or may not be added. The curd is cut when it breaks evenly before the finger. The cutting is done with curd knives made up of blades set about one-third of an inch apart in frames. In one frame the knives are set perpendicularly and in the other horizontally. When well cut the curd is in uniform cubes of about one-third of an inch.

"After being cut, the curd is heated slowly and with continued stirring until it reaches a temperature of from 96° to 108° F. With the use of mechanical agitators, as is the common practice, the curd should be heated about 4° higher than when stirring is done by hand. After heating, the stirring is continued intermittently until the curd is sufficiently firm. This is determined by squeezing a handful, which should fall apart immediately on being released. The whey is then drawn. At the same time the acid should have reached about 0.20 per cent. The curd is then matted about 4 inches deep, sometimes in the bottom of the vat, sometimes on racks covered with a coarse linen cloth. After it has remained there long enough to stick together it is cut into rectangular pieces easy to handle, which are turned frequently and finally piled two to four deep; in the meanwhile the temperature of the curd is kept at about 90° F. When the curd has broken down until it has the smooth feeling of velvet, which requires from one to three hours, it is milled by means of a machine, which cuts it into pieces the size of a finger. It is then stirred on the bottom of the vat until whey ceases to run, which requires from one-half to one and one-half hours, when it is salted at the rate of 2 or 2½ pounds of salt to 100 pounds of milk. It is then ready to be put into the press. The curd is put into tinned-iron hoops of the proper size, which are lined with cheese-cloth bandages. The hoops are put into presses and great pressure is applied by means of screws. The next morning the cheese is removed from the hoops and put on shelves in

a curing room. Formerly it was kept in a curing room as long as six months, but at the present time it is covered with a coat of paraffin and put into cold storage when from 3 to 12 days old. There is a growing demand on the part of consumers for mild cheese, and consequently ripening must be carried on at a temperature below 50° F."

Legal Definitions

The Bureau of Food and Drugs of the Texas State Department of Health (2) lists definitions and minimum requirements for 19 kinds of cheese. Among these are:

"Cheese. The product made from the separated curd obtained by coagulating the casein of milk, skimmed milk, or milk enriched with cream. The coagulation is accomplished by means of rennet or other suitable enzyme, lactic fermentation, or by a combination of the two. The curd may be modified by heat, pressure, ripening ferments, special molds, or suitable seasoning.

"The name 'cheese' unqualified means Cheddar cheese (American cheese, American Cheddar cheese).

"Cheddar Cheese, American Cheese, American Cheddar Cheese. The cheese made by the Cheddar process from heated and pressed curd obtained by the action of rennet on whole milk. It contains not more than 39 per cent of water, and, in the water-free substance, not less than 50 per cent of milk fat.

"Pasteurized Cheese, Pasteurized-Blended Cheese. The pasteurized product made by comminuting and mixing, with the aid of heat and water, one or more lots of cheese into a homogeneous, plastic mass. The unqualified name 'pasteurized cheese,' 'pasteurized-blended cheese,' is understood to mean pasteurized Cheddar cheese, and applied to a product which conforms to the standard for Cheddar cheese. Pasteurized cheese, pasteurized-blended cheese, bearing a varietal name is made from cheese of the variety indicated by the name and conforms to the limits for fat and moisture for cheese of that variety.

"Process Cheese. The modified cheese made by comminuting and mixing one or more lots of cheese into a homogeneous, plastic mass, with the aid of heat, with or without

the addition of water, and with the incorporation of not more than 3 per cent of a suitable emulsifying agent. The name 'process cheese' unqualified is understood to mean process Cheddar cheese, and applies to a product which contains not more than 40 per cent of water and, in the water-free substance, not less than 50 per cent of milk fat. Process cheese qualified by a varietal name is made from cheese of the variety indicated by the name, and conforms to the limits for fat and moisture for cheese of that variety."

CHEESE MAKING IN WISCONSIN

History

During the early life of this nation most of the cheese was made in New York. As the demand for fluid milk increased, less and less milk became available for use in cheese. Accordingly the cheese makers began to look for a new source of inexpensive milk. Before 1837 Wisconsin farmers were engaged in the production of grain, but marketing difficulties made them turn to the production of milk products. In 1837 the first cheese was made in that state and in 1841 the first coöperative plant was started there. Other important events in the development of the cheese industry in Wisconsin were the arrival of the first Swiss cheese makers' colony in 1845 and the organization of the Wisconsin Dairyman's Association in 1872. The Swiss, German, and Scandinavian races in Wisconsin were particularly adapted to work in the different phases of the dairy industry. These factors, together with the natural resources of the soil, made Wisconsin rapidly the principal producer of cheese in this country. During the last ten years, however, the increase in production in that state has not been sufficient to enable it to maintain its place in the country's market. In 1930 Wisconsin produced 64 per cent of the nation's cheese, but since that time the percentage has decreased steadily to 50.4 per cent in 1938. This does not mean that Wisconsin is producing less cheese now. That state is now producing more than it did in 1927. It simply

means that most of the expansion in the industry is taking place in new dairy states instead of in Wisconsin.

Cheese making history repeats in all dairy states, according to Sammis (11). Small factories are started in any location in which the minimum quantities of milk are available and where city markets for whole milk are not available. As the years pass and the milk supplies increase, some of the older factories, run by the best makers, gain in milk supplies faster than the average. They are able to afford the best modern equipment, can washers, pasteurizers, curing rooms, etc., and are able to produce a larger proportion of best quality cheese. Small, nearby factories are closed for lack of milk. This period is marked by a decrease in number of factories in the state, while the state production is still increasing. When the milk supply in a county is large enough, a condensary will start. This will take more or less milk from the cheese plant, since it can pay slightly more for milk than a cheese plant. Finally city milk demand and condensary demand may cause annual decrease in the state's cheese production.

Comparison with Conditions in Texas

A cycle similar to that just described took place in New York and is now taking place in Wisconsin (11). Competition for surplus milk is keen in the area north and east of Dallas and Fort Worth, but dairying has not progressed sufficiently in other parts of the State to make a large amount of surplus milk available. In 1927 there was no production of cheese other than cottage cheese in this State. The production has grown steadily until in 1938 it reached 22,910,000 pounds, or 3.16 per cent of the nation's total (9). Since Texas has about 5 per cent of the total population, *the production is still less than the consumption within the State.*

The mild climate prevailing in the greater part of Texas is both an advantage and a disadvantage. The longer grazing season results in the production of milk at a low feeding cost. Winter oats and other winter forage can be raised in

some sections of the State. Although some shelter is required, even in the Gulf coast area, this shelter is less expensive than that required in the northern states.

However there are certain advantages enjoyed by the northern dairy states which have done much to develop the cheese industry. Since the climate is cooler during most of the year, chilling the milk is seldom necessary. When it is, tap water may be used while ice is necessary in Texas. Storage of natural ice facilitates cooling to low temperatures. These factors, together with the nearness of the source to the plants, make pasteurization unnecessary. The use of good raw milk results in the production of a better-flavored cheese. The prevailing cool climate and short hauling distance to centralized curing warehouses eliminates the necessity for cold storage facilities. Since pasteurization and cold storage equipment constitute about 40 per cent of the equipment cost, a much smaller investment is necessary in plants located in the northern dairy states.

PROMOTION

GENERAL FACTORS INFLUENCING LOCATION OF A CHEESE PLANT

External Factors

There are certain fundamental factors to consider in the location of a cheese plant, and it is the location which determines very largely whether or not the venture will be successful. According to Wilson (18) there are general conditions which favor cheesemaking. Because cheese may be made during any season of the year there is always a market for the farmers' milk. The product is not only more stable than the raw material, but weighs only about one-tenth as much. Hence cheese factories are usually located in isolated sections in which there is no constant market for whole milk or sweet cream. A cheese plant requires a smaller investment than a creamery or a condensary, and can therefore operate profitably on a smaller quantity of milk.

Milk for cheese making is usually purchased on the basis of butterfat content at about the market price for fat. The

market price of cheese is usually about half that of butterfat. The whey is returned to the farmers, and since it has a definite food value for livestock, it may be considered as part of the revenue obtained from the milk. Sweet cream is purchased at the same price, and since the skim milk has a food value double that of whey, the net return to the farmer is larger. Milk sold as fluid milk brings the greatest return because all of it is used as food for human consumption. The regulations for handling fluid milk are much more strict than those for handling milk which is to be processed. Although the cheese plant gives the lowest net return to the farmer, it is able to compete in those areas in which there is no steady market for milk as fluid milk or as sweet cream.

In order for a cheese plant to operate profitably there must be available a large quantity of milk within a reasonable hauling distance. A plant beginning operations should have during the slack season at least 10,000 pounds of milk daily, with an anticipated increase to 20,000 pounds shortly. Most of the Texas plants are processing about 40,000 pounds or more daily. This milk supply must be located on roads which can be traveled all the year, and must be near enough to the plant that there be no appreciable deterioration during the hauling. Fresh, sweet milk is essential for the making of high quality cheese. In starting a cheese plant, therefore, one of the first problems to consider is whether or not there is a uniform volume of milk supply and whether or not there is already a suitable market for all of the milk being produced. A cheese plant should never be started for the purpose of raising the price of milk. If there is already a manufacturing plant established which is capable of handling all of the milk produced, the establishment of an additional plant will result in the overlapping of milk routes, and in a general loss to both plants. This will result in lower prices being paid to the farmers for their milk.

Not only the number of cattle but the quality of the cattle is important. If the cost of feeding and milking the cows is little more than the income from the milk, the

farmer will become dissatisfied and will turn his attention to some other source of revenue.

Because of bad roads and poor hauling facilities when the plants were started, distance between Wisconsin cheese factories average about four miles. Since Texas plants have started since 1927, they are much farther apart. The milk routes vary from 10 to 50 miles, depending on the condition of the roads and the milk supply. Since milk should not contain more than .20 per cent acidity on reaching the plant, long hauling is undesirable.

The plant should be located in an area having soil responsive to fertilizer in order that the natural manure resulting from the high dairy cow population will enhance the value of the land. Since dairying builds the soil, it may be considered as part of the soil conservation program. The land must be capable of ultimately producing heavy feed crops to support the dense cow population. Lime soils have been found to be especially adapted to raising feed for dairy cattle. Various type soils in Texas are discussed by Johnson (6).

The breed of cattle having a low fat content milk are preferred for cheese making areas. This is due to the fact that the ratio of casein to fat is higher when the fat content is low, as shown in Table III. Since each pound of casein adds 1.75 pounds to the cheese while each pound of fat adds only one pound, a higher casein/fat ratio means a

TABLE III

VARIATION OF CHEESE YIELD WITH FAT CONTENT
(Basis: 100 lbs. milk)

Milk fat test, per cent	3.00	3.50	4.00	4.50	5.00
Casein content, per cent	2.10	2.30	2.50	2.70	2.90
Ratio, casein/fat	.70	.657	.625	.60	.58
9/10 of milk fat, lbs.	2.70	3.15	3.60	4.05	4.50
Milk casein, lbs.	2.10	2.30	2.50	2.70	2.90
Salt, ash, lbs.	.30	.35	.40	.45	.50
Dry matter, lbs.	5.10	5.80	6.50	7.20	7.90
38.6% moisture, lbs.	3.20	3.65	4.10	4.55	5.00
Cheese yield, lbs.	8.30	9.45	10.60	11.75	12.90
Cheese per lb. fat	2.77	2.70	2.65	2.61	2.58

Reference: Sammis, *Cheese-Making*, p. 70 (11).

slightly higher yield of cheese. Since milk is bought on the basis of the fat content the net return to the plant is greater for a low butterfat milk. Since milk having about 3.6 per cent fat is used to make cheese having the necessary minimum fat content to meet legal regulations of the Pure Food and Drug Department, some of the fat may be separated from rich milk and marketed as sweet cream. Most of the cattle in the cheese producing areas in Wisconsin are Holsteins. This does not mean that any particular breed is necessary; cheese can be made from the milk of any breed cow.

Since the butterfat is bought at a price near that of sweet cream, excess butterfat above 3.6 per cent must be marketed as such or the plant will suffer a loss. It is often difficult for an isolated plant to find a steady market for the butterfat resulting from the standardization of the milk.

Internal Factors

The fact that a community has satisfied the external factors such as road conditions, location, cow population density, etc., still does not insure the successful location of a cheese plant. Since the plant must have a continuous supply of high quality milk, the farmers must be willing to do their part. There must be close coöperation between the farmers and the management of the plant. It is just as important that the farmer make money in production of milk as it is that the cheese plant be properly managed. If the farmer feels that he can make more money at some other type of work, he may stop producing milk and thereby ultimately cause the plant to fail.

It is not within the scope of this work to discuss the merits of dairying, but it should be pointed out that before any cheese plant can permanently succeed in any community the farmers must have a clear understanding of the problems involved in production of milk. A farmer cannot change from being a cotton farmer to a dairyman without some preliminary training and studying. Dairying is hard work; it means the caring for cattle 365 days out of the

year. The margin of profit is small, but there is a steady profit all of the year. The cow can be likened to a factory in which the feed is the raw material and the milk is the finished product. By a careful study of the feeding costs and milk production, the farmer can keep accurate records of his costs and see whether or not he is making a profit. Because of the small margin of profit, it is necessary that close attention be paid to these items.

There must be some driving force in the community working toward interesting the farmers in the development of dairying and toward collecting the necessary data for interesting someone in establishing a cheese plant. This may be the chamber of commerce, some civic organization, the county agent, or some individual. All this necessitates a great deal of work, but the collection of this data is essential.

Community Survey Questionnaires

Two form questionnaires are submitted, one to be used for the individual farm and the other for the community as a whole. There is no standard form for such survey records, but the securing of the information called for in these questionnaires should be of definite assistance in determining whether or not a community is a suitable location for a cheese factory.

(Submitted by Texas A. & M. College)

DAIRY QUESTIONNAIRE

City_____

Name_____Owner, Tenant or Manager_____

Post Office and Rural Route No._____

How many laying hens have you?_____What breed of chickens do you raise?_____

What is the average number of eggs you get per day?_____

How many turkeys do you normally raise?_____

How many hogs do you have?_____

How many cows are you milking?_____How many cows are dry?_____ How many heifers?_____

What breed of cows do you keep?_____

What is the average amount of milk you get daily?_____Gallons.

Do you now have any surplus whole milk?_____

How much?_____Gallons. Where do you market your dairy products?_____

Do you breed your cows to a registered bull?_____

Would you be willing to join a bull circle?_____

Do you live on a road that can be traveled every day in the year? _____. Would you be willing to deliver your milk to such road to be picked up daily?_____

If you had a steady market for whole sweet milk would you increase the number of cows milked?_____How many additional would you be willing to milk?_____

How many additional milk cans and what size will you need to purchase for a whole milk market?_____

Name _____

Address _____

Taken by_____ Date:_____

(Submitted by Damrow Brothers Company)

ADVANCE INFORMATION FOR LOCATING NEW CHEESE FACTORIES

Date_____

Town or City_____ State_____

Population _____ Railroad_____

To what products is the milk now converted?_____

Is all milk or cream now finding a ready market?_____

What is the price now paid for the milk?_____

Price of cream per pound of butterfat_____

How many miles from town to draw milk from?_____

How many cows in the territory do you expect to draw milk from? _____ Number of cows_____

Breeds _____ Pounds milk per cow_____

Average test _____

Is the water supply on the farms cool or warm?_____

Is there any alkali in the water?_____

What are the crops of your community?_____

What is the pasture, wild or planted, and what kind?_____

What per cent of farms are operated by owners?_____

What nationalities own farms?_____

What nationalities rent farms?_____

What religious creeds and schools?_____

Have any cheese factories been started in your immediate neighborhood in the last few years?_____

Were they successful?_____

If not, give reason_____

What will your community or town do towards the building, establishing, financing, and soliciting?_____

Is there a vacant building that might be utilized by remodeling or rearranging same? _____

Give dimensions in detail, floor, drainage or sewage; or make a sketch of same_____

BUILDING THE PLANT

Equipment

As stated earlier in this work, the minimum milk requirements for successful operation are 10,000 pounds of milk per day in the slack season. There is a very definite economic reason for this. One cheese maker and an assistant can do all of the work in a plant of this size, since a single vat will hold this amount of milk. If the vat is only half full of milk, the same amount of labor will be required. During the flush season the same vat may be used to make cheese twice a day. This will entail more work on the part of the cheese maker, but the size of the initial investment will be less. Then, as more milk becomes available, a second vat may be added. Variations in operating expenses in plants of various sizes are shown in Table IV.

TABLE IV

GROSS OPERATING EXPENSE PER POUND OF CHEESE FOR YEARS 1925, 1926, 1927 IN WISCONSIN CHEESE FACTORIES

Volume of Milk Received by Cheese Factories per Year	1925		1926		1927	
	Number of Factories Reporting in Each Class	Gross Expense of Manufacture per Pound of Cheese	Number of Factories Reporting in Each Class	Gross Expense of Manufacture per Pound of Cheese	Number of Factories Reporting in Each Class	Gross Expense of Manufacture per Pound of Cheese
Less than 1,000,000	3	$.0310	6	$.0311	9	$.0336
1,000,000 to 1,499,999	22	.0321	28	.0320	39	.0303
1,500,000 to 1,999,999	21	.0297	25	.0296	38	.0292
2,000,000 to 2,499,999	21	.0301	19	.0296	22	.0286
2,500,000 to 2,999,999	12	.0286	18	.0272	11	.0285
3,000,000 to 3,499,999	6	.0268	4	.0255	7	.0303
3,500,000 to 3,999,999	2	.0280	3	.0257	3	.0243
4,000,000 to 4,499,999	0	.....	1	.0300	0	.....
4,500,000 to 4,999,999	2	.0285	2	.0235	1	.0280
5,000,000 and over	2	.0245	2	.0210	2	.0220
Totals	91		108		132	

Reference: Mortensen, *Management of Dairy Plants*, p. 298 (8).

Two sets of tables, V and VI, showing the average cost of cheese making in Wisconsin plants are presented with

the permission of Mr. E. C. Damrow of Damrow Brothers Equipment Company, Fond du Lac, Winconsin, and J. L. Sammis, author of *Cheese Making*. These represent data taken by the Wisconsin Cheese Makers Association in 1933 and are based on conditions in 2200 Wisconsin plants. This equipment was carefully checked against that used in Texas plants, and was found to be about the same. Most of the present plants are using spot welded stainless steel lining tanks instead of the tinned vats suggested in these tables. These vats are almost double the price of the tin vats but they last twice as long and are easier to keep sanitary and to maintain. Most Texas plants make cheddars, prints, and longhorns instead of daisies and twins, but this does not alter the equipment cost greatly.

Both pasteurization and refrigeration are necessary in any Texas plant, as explained previously. The estimates as given under "For Southern Factory" in these tables are approximately correct. Since the cost of these two items is roughly half that of the rest of the equipment, incorporation of this cost will increase the cost per pound of cheese made in Texas. This accounts for the smaller margin of profit and larger volume necessary in Texas plants.

Every installation is a problem in itself and it is not possible to give exact figures as to the cost of equipping a plant. Since most of the equipment is available in several grades, there is room for choice. Tables V and VI are presented in order to give an idea of the size investment in equipment for the different size plants and to list necessary equipment.

TABLE V-a

EQUIPMENT FOR AN AVERAGE WISCONSIN CHEESE FACTORY USING ELECTRIC CURRENT

6,000 lbs. Milk Daily (in flush)
1,000,000 lbs. Milk Annually—100,000 lbs. Cheese Annually

MAKING DAISY CHEESE

		Cost	Years in Use	Dep. in Year
1	7,000 lb. 20 ga. Vat	$270.00	6	$ 45.00
1	2 L. S. Cheese Press	172.00	12	14.33
1	12 H. P. Boiler	527.00	15	35.13
30	Daisy Hoops at $3.75	112.50	12	9.37
1	Damrow Elec. Forking Agitator	252.75	10	25.27
1	Set Hoisting Cranes and Irons	10.50	15	.70
1	80 gal. Weighing Can and Opener	30.50	15	2.03
1	Weighing Can Strainer	13.00	10	1.30
1	20 gal. Starter Can, Elec.	120.00	8	15.00
1	700 lb. Fairbanks Scale	59.40	10	5.94
1	100 lb. Howe Scale	23.00	10	2.30
1	Set 8" Curd Knives, ¼" cut large	12.00	10	1.20
1	Curd Mill, Electric	54.50	10	5.45
1	7' Cond. Head and Spout	7.00	7	1.00
1	Strainer Curd Pail	1.75	4	.44
1	Small Tin Tank 13x26x10"	6.50	5	1.30
1	Galv. Wash Sink, Round Bottom	18.00	4	4.50
1	18' Vat Cover	7.80	3	2.60
1	Curd Fork	2.50	3	.83
1	5700 lb. Baltic Separator, No. 4 Motor Drive	889.50	12	74.13
1	6,000 lb. Tin Whey Tank	142.00	10	14.20
1	D S K Vik. Pump	125.95	5	25.19
1	D K Vik. Pump	128.95	5	25.79
	Sanitary Fittings	45.00	10	4.50
1	7,875 lb. Round Redwood Tank 31½ bbl.	49.86	12	4.15
1	6" Wood Whey Pump	12.00	3	4.00
1	Adjustable Conductor Head and Spout	6.50	2	3.25
4	Dozen ½ pt. Sample Bottles with numbers at $1.90	7.60	3	2.53
1	25 bottle Babcock Tester, Electric	58.00	12	4.83
1	Test Bottle Bath, 24 bot.	4.00	5	.80
1	Divider	.65	5	.13
1	Marschall Rennet Test	2.50	10	.25
1	Marschall Acid Test	5.00	3	1.66
1	Vacuum Sediment Tester	10.00	8	1.25
1	20 Sample Moisture Oven, Electric	25.00	10	2.50
1	No. 1715 Torsion Balance	39.00	10	3.90
1	Daisy Curd Scoop	2.00	5	.40
1	Cheese Knife	1.00	10	.10
1	4 Quart Dipper	$ 2.50	2	$ 1.25
1	Cheese Trier	5.50	2	2.75
1	Pay and Record Book, 50 Patrons	3.00	4	.75

TABLE V-a (Continued)

		Cost	Years in Use	Dep. in Year
1	2x2x4′ Galv. Water Tank	6.30	6	1.05
	Steam Pipe and Fittings, Valves, etc., and Labor	60.00	16	3.75
	Transmission, including 24′ 1¼″ Shaft at $0.34	$ 8.16		
	1 Shaft Coupling	2.75		
	4 1¼″ Hangers 14″ drop $4.55	18.20		
	2 24x6 Wood Pulleys	14.85	53.49	16	3.34
	2 12x6 Wood Pulleys	7.35		
	1 4x4 Wood Pulley	2.18		
		$3,386.00		$360.14
	Depreciation a year 10.6 per cent.			
	For Southern Factory			
	Pasteurization equipment	$1,500.00		
	Refrigeration	2,000.00		
	Boiler required when pasteurizing 20 H. P.			

TABLE V-b

COST OF MAKING CHEESE IN AN AVERAGE WISCONSIN FACTORY DURING 1933

6,000 lbs. Milk Daily (in flush)

1,000,000 lbs. Milk Annually — 100,000 lbs. Cheese Annually

General Supplies			
32 Gallons Rennet (5 gal. lots), per gallon	$1.95		$ 62.40
8 Gallons Color (5 gal. lots), per gallon	1.85		14.80
9 Barrels Salt, per barrel	3.60		32.40
5 Gallons Acid	-----		7.25
Misc. Supplies, Starter Neutralizer, etc.	-----		10.00
Stationery and Milk Books	-----		3.00
Cleaning Powders and Brushes	-----		50.25
Oil for Engine and Separator	-----		15.20
Glassware and Breakage	-----		10.00
Retinning Hoops, average per year	-----		14.00
Allowance for Repair	-----		55.00
50 Tons Coal, per ton	7.50		375.00
			$649.30
Fixed Expenses			
Depreciation on Equipment	$3,386.00	10.6%	$358.92
Depreciation on Building	5,500.00	3.0%	165.00
Interest on Investment	8,686.00	6.0%	521.16
Insurance on Building and Equipment	-----	-----	40.00
Taxes	-----	-----	45.00
			$1,130.08

TABLE V-b (Continued)

VARIABLE SUPPLIES

Single Daisy

5,000	Bandages 13½x6½", A Grade, per thousand	$18.50	$ 92.50
10,000	Circles 12½", per thousand	7.90	79.00
500	Press Cloths 14", per thousand	22.15	11.08
5,000	Boxes, each	.12	600.00
10	Bundles 13" Scale Boards, per bundle	2.10	21.00
			$803.58

Twins

3,125	Bandages 14½x8½", A Grade, per thousand	$24.85	$ 77.66
6,250	Circles 13½", per thousand	9.00	56.25
500	Press Cloths 14", per thousand	22.15	11.08
1,563	Boxes, each	.22	343.86
3¼	Bundles 14" Scale Boards, per bundle	2.30	7.48
			$496.33

Longhorns

7,690	Bandages 6x15½", A Grade, per thousand	$21.65	$166.49
15,380	Circles 5", per thousand	1.45	22.30
1,000	Press Cloths 6", per thousand	4.45	4.45
1,923	Boxes, each	.22	423.06
4	Bundles 14" Scale Boards, per bundle	2.30	9.20
			$625.50

COST OF MAKING ONE POUND OF CHEESE IN AN AVERAGE FACTORY

	Single Daisy	Twins	Long Horn
Cost of Different Styles	$.00803	$.00496	$.00625
General Supplies	.00649	.00649	.00649
Total Cost of Supplies	$.01452	$.01145	$.01274
Fixed Expenses	.01130	.01130	.01130
Cost without Labor	$.02582	$.02279	$.02404
Labor Cost ($1,200 year)	.01200	.01200	.01200
Total Cost of Making 1 lb.	$.03782	$.03479	$.03604

The average cheese factory in Wisconsin runs about 1,375,000 pounds of milk during a year which makes approximately 100,000 pounds of cheese.

When a factory runs more or less milk the only difference in cost of making a pound of cheese would be the "Fixed Expenses" and "Labor Cost."

Whey Cream Fat 3,000 lbs. a year at $.23, $690.00. Cartage of Cheese and Coal done by the farmers.

TABLE VI-a

EQUIPMENT FOR A LARGE WISCONSIN CHEESE FACTORY USING ELECTRIC CURRENT

18,000 lbs. Milk Daily (in flush)
3,000,000 lbs. Milk Annually—300,000 lbs. Cheese Annually

MAKING DAISY AND LONGHORN CHEESE

		Cost	Years in Use	Dep. in Year
2	10,000 lbs. 20 gal. Vats., $328.00	$656.00	6	$109.33
2	2 LS Presses 20′, $221.00	442.00	12	36.83
1	20 H. P. Boiler	666.00	15	44.40
	Two Sets of Hoops			
90	Daisy Hoops, $3.75	337.50	12	28.13
96	Longhorn Hoops, $3.70	355.20	12	29.60
2	Damrow Electric Forking Agitators, $262.75	525.50	10	52.55
1	Hoisting Crane and Irons	10.50	15	.70
1	100 gal. Weigh. Can and Opener	35.50	15	2.37
1	Weighing Can Strainer	15.00	10	1.50
1	1,000 lb. Fairbanks Scale 7 bm	76.50	10	7.65
1	200 lb. Howe Scale	32.00	10	3.20
1	50 gal. Start. Can Motor Drive	175.00	8	21.88
1	Set Curd Knives ¼″ Cut Large	45.00	10	4.50
1	Curd Mill Electric	54.50	10	5.45
2	7′ Cond. Heads and Spouts, $7.00	14.00	10	1.40
2	20′ Vat Covers, $9.00	18.00	3	6.00
2	Strainer Curd Pails, $1.75	3.50	4	.87
2	Small Tin Tanks 20x27x13, $9.50	19.00	5	3.80
2	Curd Forks, $2.50	5.00	8	.63
1	8,500 lb. Baltic Separ. No. 6 Motor Drive	953.60	12	79.47
1	11,500 lbs. 20 gal. Round Bottom Whey Tank	243.00	10	24.30
1	D S L Vik. Pump	166.25	5	33.25
1	D K Vik. Pump	128.95	5	25.79
	Sanitary Fittings	60.00	10	6.00
1	20,000 lbs. Round Redwood Whey Tank, 80 bl.	130.50	12	10.88
1	7″ Wood Whey Pump	15.00	3	5.00
1	Adj. Whey Cond. Spout	6.50	2	3.25
1	36 bot Babcock Test. electric	74.75	12	6.23
8	Doz. ½ pt. Sample Bottles with Nos. and Chain, $1.90	15.20	3	5.06
1	36 Bot. Test Bottle Bath	5.25	5	1.05
1	Gal. Wash Sink Round Bottom	18.00	4	4.50
1	Cheese Knife	1.00	10	.10
1	Speed Knife	1.50	8	.19
2	L. H. Scoops $2 and $3.25	5.25	10	.52
2	Daisy Scoops, $2.00 and $3.25	5.25	10	.53

TABLE VI-a (Continued)

		Cost	Years in Use	Dep. in Year
2	4 qt. Dippers 19" handle, $2.60	5.20	8	.65
1	Cheese Trier	5.50	20	.27
1	Divider	.65	5	.13
1	Marschall Rennet Test	2.50	10	.25
1	Marschall Acid Test	5.00	3	1.67
1	Vacuum Sediment Test	10.00	8	1.25
1	Electric Moisture Oven	20.00	10	2.00
1	No. 1715 Torison Balance	39.00	10	3.90
1	Pay and Record Book	3.50	2	1.75
1	2x2x4 Water Tank	6.30	6	1.05
	Steam Pipes, Fittings, Valves, Etc. and Labor	150.00	16	9.37
	Transmission, including 30 ft. 1½" Shafting, 48c $14.40 4 1½" Hangers 14" drop $5.50 each 22.00 1 Shaft Coupling 3.00 2 14x8 Wood Pul'y 10.00 2 4x4 Wood Pul'y 4.35	53.75	16	3.36
	4 Double Deck L. H. Truck 80 Ch., $30.00	120.00	10	12.00
		$5,737.10		$604.56

Depreciation a year 10.53 per cent.

For Southern Factory

Pasteurization equipment $1,800.00
Refrigeration equipment 2,500.00
Can Washer $1,000.00 to $3,600.00

A 40 H. P. Boiler is required when pasteurizing and can washing.

TABLE VI-b

COST OF MAKING CHEESE IN A LARGE WISCONSIN FACTORY DURING 1933

18,000 lbs. Milk Daily (in flush)
3,000,000 lbs. Milk Annually 300,000 lbs. Cheese Annually

General Supplies			
96 Gallons Rennet (10 gal. lots), per gallon		$1.85	$177.60
24 Gallons Color (5 gal. lots), per gallon		1.85	44.40
27 Barrels Salt, per barrel		3.60	97.20
10 Gallons Acid			9.80
Miscellaneous Supplies, Starter Neutralizer, etc.			19.25
Stationery and Milk Books			4.00
Cleaning Powders and Brushes			87.70
Oil for Engine and Separator			22.40
Glassware and Breakage			18.80
Retinning Hoops, average per year			35.00
Allowance for Repair			75.00
80 Ton Coal, per ton		7.50	600.00
			$1,191.15
Fixed Expenses			
Depreciation on Equipment	$ 5,737.00	10.53%	604.11
Depreciation on Building	8,000.00	3%	240.00
Interest on Investment	13,737.00	6%	824.22
Insurance on Building and Equipment			65.00
Taxes			70.00
			$1,803.33
Variable Supplies			
Single Daisy			
15,000 Bandages 13½x6½ A Grade, per thousand		$18.50	$277.50
30,000 Circles 12½", per thousand		7.90	237.00
1,500 Press Cloths 14", per thousand		22.15	33.23
15,000 Boxes, each		.12	1,800.00
30 Bundles Scale Boards, 13", per bundle		2.10	63.00
			$2,410.73
Twins			
9,380 Bandages 14½x8½ A Grade, per thousand		$24.85	$ 233.09
18,760 Circles 13½", per thousand		9.00	168.84
1,500 Press Cloths 14", per thousand		22.15	33.23
4,690 Boxes, each		.22	1,031.80
9½ Bundles 14" Scale Boards, per bundle		2.30	21.85
			$1,488.81

TABLE VI-b (Continued)

Daisy and Longhorns

7,500 Daisy Cheese 150,000 lbs.		11,540 L. Horn Cheese 150,020 lbs.	
7,500 Bandages 13½x6½ A Grade, per thousand	$18.50	$138.75	$ 388.59
11,540 L. H. Bandages 6x15½ A, per thousand	21.65	249.84	
15,000 Circles 12½", per thousand	7.90	118.50	151.97
23,080 L. H. Circles 5", per thousand	1.45	33.47	
1,000 Press Cloths, 14", per thousand	22.15	22.15	31.05
2,000 L. H. Press Cloths 6", per hundred	4.45	8.90	
7,500 Daisy Boxes, each	.12	900.00	1,534.70
2,885 L. H. Boxes, each	.22	634.70	
15 Bundles 13" Scale Boards, per bundle	2.10	31.50	45.30
6 Bundles 14", per bundle	2.30	13.80	
			$2,151.61

COST OF MAKING ONE POUND OF CHEESE IN A LARGE FACTORY

	Single Daisy	Twins	Longhorn and Daisy
Cost of Different Styles	$.00803	$.00496	$.00717
General Supplies	.00397	.00397	.00397
Total cost of Supplies	.01200	.00893	.01114
Fixed Expenses	.00601	.00601	.00601
Cost without Labor	.01801	.01494	.01715
Labor Cost ($2,400 year)	.00800	.00800	.00800
Cost of Making One Pound	.02601	.02294	.02515
Whey Cream 3 per cent 9,000 lbs. a year at $.23		$2,070.00	Cartage done by the farmers.

Definite help in making up the list and cost of equipment for any particular plant can be obtained from the makers of dairy equipment. Engineers with these companies will design and quote on the needs suitable to any problem. These men have had experience in the building and equipping of plants and are able to recommend the necessary

equipment and plant lay-out. If a contract is made with a major company for the handling of the cheese production, that company will assist in the selection of equipment and in the building of the plant. Further advice may be obtained from Extension Specialist in Dairy Manufacturing, Texas Agricultural Extension Service, College Station, Texas. The largest distributors of cheese plant equipment in Texas are Creamery Package Company, 801 Ross Avenue, Dallas, and Meyer-Blanke Equipment Company, 3215 Canton Street, Dallas. A complete list of all manufacturers is available in the *Dairy Industries Catalogue* of equipment, supplies and services used by the dairy products manufacturers, published by the Olsen Publishing Company, 505 West Cherry Street, Milwaukee, Wisconsin.

Building

Floor plans are printed in each of the three books on cheese making. Help on this may be obtained from the same sources as on equipment. A detailed set of blueprints for a cheddar cheese plant processing 20,000 pounds of milk a day is available from the Bureau of Agricultural Chemistry and Engineering, Department of Agriculture, Washington, D.C. The cost of the building represented in these plans will be about $12,000. Before constructing a building it is suggested that a copy of *Public Health Bulletin 220, Public Health Service, Milk and Ordinance Code* (price 35 cents) be secured from Superintendent of Documents, Washington, D.C. Although this bulletin is written primarily for fluid milk plants, valuable suggestions for sanitation in cheese plants may be found in it. Further details regarding sanitation are available from the Engineering Division, State Health Department, Austin.

It is often possible to use some available building to house the plant. The chief concern is the sanitation. It is necessary that a cement floor having the proper slope to the drains be used in order that the wastes will not collect and decompose. It is suggested that floor plans of available

FIG. 2.—Berryville Cheese Factory, Berryville, Arkansas.

buildings be compared to those found in the books mentioned above. It is often better to rent a building until the success of the enterprise has been assured.

TABLE VII

SUMMARY OF COSTS FOR A TEXAS CHEESE PLANT

(Approximate)

10,000 POUNDS OF MILK DAILY

General equipment	$ 4,000
Pasteurization equipment	1,500
Refrigeration equipment	2,000
Building	7,000
Total	$14,500

20,000 POUNDS OF MILK DAILY

General equipment	$ 6,000
Pasteurization equipment	1,800
Refrigeration equipment	2,500
Building	10,000
Total	$20,300

Sewage Disposal

In planning the location of a cheese plant it is important that the matter of disposal of the wastes be carefully considered. Plants were formerly built near running streams in order that wastes might be disposed of by dumping into the water. However Article 4444 of the Revised Civil Statutes of 1925 forbids the introduction of any material into streams in Texas which would in any way injure the water life. These regulations are enforced by the Engineering Division of the State Health Department. Since milk solids are known to be excellent food for fish and other marine life, it might be felt that no harm would result from the introduction of these wastes into streams. Briefly the difficulty may be explained (4) as follows: Bacterial action causes the rapid decomposition of the milk solids. One type of action takes place in the presence of oxygen (aerobic) and the other in the absence of oxygen (anaerobic). As the milk waste enters the stream containing dissolved air it rapidly uses up most of the available oxygen.

Anaerobic action then begins, resulting in the formation of septic conditions, bad odors, general nuisance, and the complete depletion of the oxygen resulting in the destruction of all forms of water life by suffocation.

The wastes from cheese plants consist of the floor washings, drippage from the milk cans, and the whey. The whey constitutes the bulk of waste, but since most of this is used by the farmers for livestock feeding, there is little difficulty in disposing of this material. During the flush seasons, however, there may be more available than the farmers can use. By careful operation the other wastes can be kept at a minimum, although they cannot be eliminated. Since the wastes are high in milk sugars, they tend to ferment readily. This results in the development of high acidity which will injure the organisms in the ordinary Imhoff tank type installation. Pretreatment at the plant is usually necessary. The most successful treatment is biological filtration, which consists of the intermittent application of the waste to a filter composed of gravel or crushed stone. After a period of use, there is a development of a growth of oxidizing bacteria on the stone. These bacteria oxidize the milk solids to a more stable form, resulting in a reduction of the oxygen demand. If a filter of this type is properly operated, it should reduce the oxygen demand by 90 to 95 per cent.

The Engineering Division of the State Health Department recommends that arrangements be made for disposal of whey by some method other than the city sewer, and that floor washings and drippings be washed into the city disposal system. Before this is done, however, it recommends that the city disposal system be studied by the Division to determine whether or not it has sufficient capacity to handle the additional flow. Plans for the building should be sent to the State Health Department for suggestions regarding sanitation. Further advice regarding disposal problems may be obtained from the Chief Sanitary Engineer, State Health Department, Austin. This department would rather

assist in the design of disposal facilities than have to recommend changes after the plant is built.

OPERATION OF THE PLANT

Labor Requirements

The importance of securing the services of a competent and reliable cheese maker cannot be overemphasized. In an organization handling 10,000 pounds of milk a day the careless handling of a single vat of milk may result in the loss of enough money to pay the salary of a good cheese maker for the entire month. If the cheese does not age properly it will not bring the market price.

The minimum labor requirements are for one cheese maker and an assistant. The maker will probably command a salary of $150 or more per month, while the salary of the assistant will be less. When the assistant has worked for a period of from two to four years, he may be qualified to go into another plant as cheese maker. Thus the number of cheese makers available grows with the industry. Since the cheese industry has developed so rapidly in Texas, there has not been time to build up a large supply of men who have had sufficient experience.

The A. & M. College at College Station and the Texas Technological College at Lubbock offer degrees in the Manufacture of Dairy Products. Men taking these degrees have been taught the making of cheese in connection with their general study of dairy products. Information in regard to these men may be obtained from Head of Dairy Husbandry Department, A. & M. College, College Station, Texas, and Head of Department of Dairy Manufactures, Texas Technological College, Lubbock, Texas. Advice in securing the services of cheese makers who have served as apprentices in other plants can be obtained from the firm which contracts for the cheese or from some of the plants which are operating in Texas at the present time. A complete list of plants is published by Buechel and Johnson (1).

Patent Control

In starting a new business one is interested in knowing to what extent the operation of that business will be affected by existing patents. Nearly all of the important discoveries in milk processing during the last 50 years have been patented (15). This means that for the limited time of 17 years commercial application of these processes is limited to the individual or company holding the patent rights or to the company to which the patentee may choose to sell or lease the process. No patents in this country have been granted on the principle of pasteurizing of milk and cream, although equipment used in this process has been patented. No patents relating to butter have any great commercial significance at present. The mechanics and basic chemical processes involved in making butter have been known for centuries and cannot be patented. Likewise the making of cheese is a universal process and no important patents relate to it.

There are, however, many patents of great commercial value relating to the making of process cheese (5). The basic patents on processing were granted to the Kraft-Phenix Cheese Corporation. One of the most important of these covered the process of heating and pasteurizing of cheese in such a way as to prevent the separation of fat globules from the milk solids. This broad coverage gave this company virtual control of the basic methods for making process cheese. The main patents have run out within the last few years, but a number of new patents on process cheese have been issued, not only to Kraft but to a number of other companies. It remains to be seen what control these patents will give to the holders.

Production Data

The Bureau of Business Research of The University of Texas obtains confidential reports of production of cheese and other dairy products from key plants over the State each month. On the basis of these reports this Bureau is able to estimate the monthly production of cheese in Texas.

These estimates are then made available to the contributing firms. This service is very valuable to the established cheese industry in Texas.

A good discussion of the national picture of consumption and production of cheese and other dairy products is given by Vial (17) in a bulletin published in April, 1940.

FINANCING

ORGANIZATION OF THE PROJECT

Coöperative

Practically all of the early cheese factories in Wisconsin were started as coöperative ventures. In order to market their products the farmers in a community would organize a company, build a plant, and hire a cheese maker. The hauling of milk and of the finished product was done by the farmers. Operation of the plant was intrusted to a board of three members, much like a school board. The turnover of labor was high, each maker being awarded a one-year contract and seeking each year to get a better contract. All profits were divided among the farmers on the basis of the milk fat brought in by them.

Coöperative plants have the advantage in that the farmers will not tend to sell their milk to other concerns if they have a definite interest in the cheese plant. The plants must be properly managed, however, or there will be a lack of harmony among the patrons. In those communities in which the coöperative spirit has been developed, however, this type of organization should be as successful for cheese plants as for any other type of business.

There are a number of different types of organizations under which a coöperative venture may be formed. If the association is to borrow money from a bank for coöperatives, those drafting the organization papers should remember the terms of the Farm Credit Act of 1933, as amended (12 U.S.C. 1141 j) :

"As used in this act the term 'coöperative association' means any association in which farmers act together in

processing, preparing for market, handling, and/or marketing the farm products of persons so engaged, and also means any association in which farmers act together in purchasing, testing, grading, processing, distributing, and/or furnishing farm supplies and/or farm business services; *Provided, however,* That such associations are operated for the mutual benefit of the members thereof as such producers or purchasers and conform to one or both of the following requirements:

"First. That no member of the association is allowed more than one vote because of the amount of stock or membership capital he may own therein; and

"Second. That the association does not pay dividends on stock or membership capital in excess of 8 per centum per annum. And in any case to the following:

"Third. That the association shall not deal in farm products, farm supplies, and farm business services with or for nonmembers in an amount greater in value than the total amount of such business transacted by it with or for members."

A thorough discussion of the organization of coöperatives may be found in *Organizing a Farmers' Coöperative,* Circular No. C-108, S. D. Sanders, Farm Credit Administration (10) and *Coöperative Marketing of Dairy Products,* Circular No. C-116, Harry C. Trelogan and French M. Hyre, Farm Credit Administration (12). Both of these are available on request from Director of Information and Extension, Farm Credit Administration, Washington, D.C. Definite help in the organization of the coöperative venture may be obtained from the Coöperative Marketing Specialist, Texas Agricultural Extension Service, College Station, Texas. The forms should be carefully checked with the laws of the State of Texas by a competent attorney, and such changes made as will make them consistent with the statute under which the association is to be incorporated.

According to the provisions of the Farm Credit Act of 1933 a bank for coöperatives may not lend a coöperative association funds to finance facilities in excess of 60 per cent of the collateral offered. This may serve as a guide,

FIG. 3.—Kraft-Phenix Cheese Corporation Factory, Winnsboro, Texas.

since organizers of a coöperative venture must be prepared to raise initially 40 per cent of the cost of the plant as well as to provide the operating capital. If the project is properly organized and shows good prospects for success, financing can be arranged through the Houston Bank for Coöperatives, Houston, Texas. This is a branch of the Farm Credit Administration.

Major Company

There are a number of companies in the State having a chain of cheese plants. Among these are Kraft-Phenix Cheese Corporation, Denison; Armour and Company, Fort Worth; and Swift and Company, Fort Worth. These and other companies are interested in establishing new plants in any area in which there is an assurance of a continued supply of milk. If there is no desire for a coöperative plant or an independent plant, a request may be made to one of the major companies asking that a plant be located in the community. In order to interest one of these companies, however, a detailed community survey must be made, showing the density of the dairy cow population and the other factors mentioned as essential to successful plant location. There must be definite interest in the project among the farmers, because this is one of the principal factors of successful plant location.

If a survey of conditions shows a favorable inclination toward the establishment of a cheese plant, it should not be difficult to interest one of the companies in making a more thorough investigation. There are certain advantages to large scale operation in cheese manufacturing. The cheese may be more easily marketed. The plant has the advantage of the background of experience gained in other plants. The company will send a corps of experts to assist the farmers in buying dairy cattle and increasing the yield per cow. Everything possible will be done to enable the farmer to make a larger profit on his milk, because it is to the company's advantage to have the farmer increase his milk production.

MARKETING

Processed Cheese

Approximately 40 per cent of the American and foreign types of cheese produced in this country is marketed as processed or blended cheese and as cheese spread. The rise of processing has done much to help the position of the independent and coöperative plants which are engaged in the production of American cheese. This cheese is the raw material for the processed cheese, and as the demand for the processed material increases, it will cause an increase in demand for American cheese.

Contracting Companies

As was pointed out earlier in this report a contract may be made with one of the major distributing houses for the purchase of the entire cheese production each day on the basis of the weekly market price. This price is determined each Friday by the sales at the cheese board in Plymouth, Wisconsin. These contracts are usually made on a one-year basis, but can be renewed as often as desirable. Since it is very difficult and expensive to build up a market for an unknown brand of cheese, this is the recommended procedure for a new independent or coöperative plant. If the marketing cost must be added to the expense of the plant, the overhead will be increased considerably. Another item to consider is the cold storage requirements. If the cheese is contracted for, only about ten days storage capacity is necessary. This is due to the fact that the company receiving the cheese will provide the cold storage capacity necessary for the aging.

Among the companies contracting for cheese in Texas are: Armour and Company, Fort Worth, Texas; Cudahy and Company, Chicago, Illinois; Kraft-Phenix Cheese Corporation, Denison, Texas; and Wilson and Company, Houston, Texas.

A complete discussion of cheese warehousing and marketing in Wisconsin is given in *Large Scale Organization in the Dairy Industry,* Circular 527, United States Department of

Agriculture (5). No similar study is available for conditions in Texas. There is much more centralization in the marketing of cheese than in the production. Cheese is normally made at a small plant, held in storage a few days, and then shipped to cheese warehouses where it is paraffined, stored, and aged (cured). In Wisconsin in 1935 there were 93 warehouses, of which 10 were coöperatives, 20 were independents, and 63 were operated by national companies.

Marketing Channels

In general the marketing channels for cheese are the same as those for butter except that much of the cheese is handled by specialized jobbers who service retail stores and restaurants every few days. This is particularly true for processed cheese and special types of natural cheese, for which the major dairy companies have distributing agencies in most of the large cities in the country. The meat packers sell about three-fourths of their cheese to independent retailers, while the large dairy companies sell about half of theirs to this outlet and substantial quantities to grocery chains. All types of large scale handlers sell some cheese to wholesalers, who in turn sell to retailers. Most of the large companies, however, handle their own wholesale distribution of cheese products.

Some cheese is being marketed in Texas by independent companies as "Texas cheese." This is finding a gradually increasing market. Some of the established plants having enough storage capacity to properly age the cheese have found that they are able to put their product directly into the retail marketing channels.

SUMMARY

The cheese industry has grown very rapidly in Texas during the last twelve years, and there is room for more growth in the future. Milk is made up of water, fat, and solids-not-fat; cheese making simply means the splitting up of the milk constituents into two components known as the cheese and the whey. The Pure Food and Drug Division of the State Health Department defines 19 kinds of cheese and gives the fat content necessary for each kind. Of these only American Cheddar cheese is of importance to the manufacturers of cheese in Texas.

Conditions in Texas favor cheese making. The cattle can be pastured most of the year; much of the land is fertile and can be used for raising feed. However, pasteurization and cold storage facilities are necessary here, resulting in a larger investment in equipment.

Cheese plants are best located in an area away from the fluid milk and sweet cream market. There must be an excess of fluid milk so located that it can be delivered to the plant in good condition every day. The minimum quantity of milk necessary is 10,000 pounds during the slack season. The plant might be started as a coöperative plant or by a major company, depending on the will of the community.

The equipment for a plant necessary to process this minimum amount of milk would cost from seven to ten thousand dollars, depending on the quality equipment desired. If a building must be built it would cost roughly the same. Blue prints and floor plans are available in the sources mentioned in this bulletin, and closer estimates may be obtained on the basis of these. Assistance in buying proper equipment and in building design may be obtained from the equipment companies and from the company contracting for the cheese output. Sewage disposal facilities should be checked by the State Health Department.

A good cheese maker is essential to the successful operation of any plant. Such a man may be obtained through one of the agricultural colleges or from one of the cheese plants.

There is essentially no patent control in the manufacture of cheese for the wholesale market. There is some control in process cheese, but since American cheese is the raw material for most of the processed, the rise in demand for this type will increase the wholesale market for American Cheddar. Some of the Texas cheese is sold directly to the wholesale jobber, although most of it is either processed or handled through the national companies' own distribution systems.

Summary of Sources of Information

Plant equipment
- Meyer-Blanke Equipment Co., Dallas, Texas
- Creamery Package Co., Dallas, Texas
- Damrow Brothers, Fond Du Lac, Wisconsin

Building plans
- Bureau of Agricultural Chemistry and Engineering, United States Department of Agriculture, Washington, D.C.
- *Cheese Making*, Sammis; *Cheese*, Van Slyke and Price; and *The Book of Cheese*, Thom and Fisk
- Companies contracting for cheese

Sewage Disposal
- Engineering Division, State Department of Health, Austin, Texas

Labor
- Dairy Department, Texas A. & M. College, College Station, Texas
- Dairy Department, Texas Technological College, Lubbock, Texas
- Existing plants in Texas

Operation
- Extension Specialist in Dairy Manufacturing, Texas Agricultural Extension Service, College Station, Texas
- Companies contracting for cheese

Financing
- Coöperative Marketing Specialist, Texas Agricultural Extension Service, College Station, Texas
- Houston Bank for Coöperatives, Houston, Texas
- Circulars No. C-108 and C-116, Farm Credit Administration, Washington, D.C.

Companies contracting for cheese
- Armour and Co., Fort Worth, Texas
- Cudahy and Co., Chicago, Ill.
- Kraft-Phenix Cheese Corporation, Denison, Texas
- Wilson and Co., Houston, Texas

Names and locations of existing cheese plants in Texas
- *Manufacture of Dairy Products in Texas*, Buechel and Johnson

PARTIAL LIST OF BOOKS RELATING TO CHEESE MAKING

Manufacture of Dairy Products in Texas, Bureau of Business Research, The University of Texas (1938), price $1.00. This publication gives an accurate, statistical picture of the manufacture of dairy products in the State. The State is divided into 10 regions or districts and exact data is given for each district. For the years 1924, 1929, and 1934 the number of acres in each region is shown under each of the following classifications: crop land harvested, failure, and idle or fallow; pasture land plowable, woodland, and all other; woodland not pastured; all other land in farms; per cent of total acreage in crop land harvested and in all other land. The acreage in cotton, corn, wheat, sorghum, oats, and other crops is given by districts. By counties is given the data on number of farms reporting cows milked, number of cows milked, milk produced, and butter produced on farms. Monthly cheese production is given for the State as a whole for 1930–1937 inclusive. The names and locations of all the cheese plants within the State are included.

Cheese Making, J. L. Sammis, The Cheese Maker Book Co., Madison, Wisconsin (1937), price $2.75. This is a good book for practical cheese makers, factory patrons, agricultural colleges, and dairy schools. The first part of the book is devoted to general facts concerning the history, establishment, and management of cheese plants. The second part goes into detail about cheese varieties, classification, and manufacture. The book is excellent for the layman desiring a general picture of the cheese industry.

Cheese, Van Slyke and Price, Orange Judd Publishing Co., New York (1938), price $3.50. This is essentially a treatise on manufacture of American cheddar cheese and other varieties. It can be used as a handbook and work of reference for the daily use of practical cheese makers in cheese factory operations.

Fundamentals of Dairy Science, Associates of Rogers, Reinhold Publishing Co., New York (1935), price $6.00. This is a scientific classic in the American Chemical Society Monograph Series. It is an exhaustive study of the chemistry of milk and milk products.

United States Department of Agriculture Bulletins. A complete list of books on all phases of dairy technology may be obtained from the Bureau of Dairy Industry, U.S. Department of Agriculture, Washington, D.C. A list of the bulletins available from Washington relating to all phases of this problem is available on request.

Dairy Industries Catalogue, Olsen Publishing Company, Milwaukee, Wisconsin. This is a complete catalogue of equipment, supplies, and services used by all dairy products manufacturers. It contains a complete list of trade names, statistics on dairy products manufacture, lists of dairy schools and experiment stations and their staffs, state food, drug and health officials, associations, and other useful information.

Management of Dairy Plants, Martin Mortensen, The Macmillan Company, New York (1938), price, $3.00. While this book is written for all types of dairy plants, much of the information is applicable to cheese plants. It presents an accurate picture of the engineering cost principles and business management of dairy plants. Among the topics covered are organization, construction, sewage disposal, refrigeration, steam generation, personnel, purchasing, manufacturing costs, marketing, advertising, credits and collections, etc.

BIBLIOGRAPHY

(1) Buechel, F. A., and Johnson, Elmer H., *Manufacture of Dairy Products in Texas*, Bureau of Business Research, The University of Texas, Austin, Texas (1938).

(2) Cox, George W., *Texas Food and Drug Laws*, State Department of Health, Bureau of Food and Drugs, Austin, Texas (1939).

(3) Doane, C. F., and Lawson, H. W., *Varieties of Cheese: Descriptions and Analyses*, U.S. Department of Agriculture, Bulletin No. 608 (1932).

(4) Eldridge, E. F., *The Disposal of Wastes from Milk Products Plants*, Agricultural Experiment Station, East Lansing, Michigan (1936).

(5) Froker, R. K., Colebank, A. W., and Hoffman, A. C., *Large-Scale Organization in the Dairy Industry*, U.S. Department of Agriculture, Circular No. 527 (1939).

(6) Johnson, Elmer H., *The Natural Regions of Texas*, Bureau of Business Research, The University of Texas, Monograph No. 8 (1931).

(7) Mojonnier, T., and Troy, H. C., *The Technical Control of Dairy Products*, Mojonnier Brothers Company, Chicago, Illinois (1925).

(8) Mortensen, Martin, *Management of Dairy Plants*, The Macmillan Company, New York (1938).

(9) Olsen Publishing Company, *Dairy Industries Catalog*, Milwaukee, Wisconsin (1940).

(10) Rogers, Associates of, *Fundamentals of Dairy Science*, Reinhold Publishing Corporation, New York (1935).

(11) Sammis, J. L., *Cheese Making*, The Cheese Maker Book Company, Madison, Wisconsin (1937).

(12) Sanders, S. D., *Organizing a Farmers' Coöperative*, Circular No. C-108, Farm Credit Administration (1939).

(13) Thom, Charles, and Fisk, W. W., *The Book of Cheese*, The Macmillan Company, New York (1938).

(14) Trelogan, Harry C., and Hyre, French M., *Coöperative Marketing of Dairy Products*, Circular No. C-116, Farm Credit Administration (1939).

(15) United States Agricultural Adjustment Administration, *A Survey of Milk Marketing in Milwaukee*, Ser. DM-1, U.S. Agricultural Adjustment Administration Marketing Information (1937).

(16) Van Slyke, L. L., and Price, W. V., *Cheese*, Orange Judd Publishing Company, New York (1938).

(17) Vial, Edmund E., *Production and Consumption of Manufactured Dairy Products*, U.S. Department of Agriculture, Technical Bulletin No. 722 (1940).

(18) Wilson, H. L., *Points to Consider in Establishing a Cheese Factory*, U. S. Department of Agriculture, Miscellaneous Publication No. 42 (1928).